ORIGINAL ARTICLE

Patient-Reported Cognitive and Communicative Functioning: 1 Construct or 2?

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ABSTRACT. Hula WD, Doyle PJ, Austermann Hula SN. Patient-reported cognitive and communicative functioning: 1 construct or 2? Arch Phys Med Rehabil 2010;91:400-6.

Objectives: To examine the dimensionality of scales for measuring patient-reported cognitive and communicative functioning in a sample of stroke survivors and to evaluate the consequences for measurement of treating them as a single, undifferentiated construct.

Design: Secondary analysis of existing cross-sectional data.

Setting: Data were collected in outpatient rehabilitation clinics and in the community.

Participants: Unilateral stroke survivors (N=316) 3 months or more postonset referred for participation in research.

Interventions: Not applicable.

Main Outcome Measures: The Burden of Stroke Scale cognition and communication domain scales were evaluated by using confirmatory factor analysis, Rasch analysis, and tests of differential item functioning (DIF). To evaluate the impact of multidimensionality on the measurement of individual patients, separately estimated cognition and communication scores were compared. Combined and separately estimated scores were also examined for responsiveness to group differences in the presence of cognitive and communicative impairment.

Results: Factor analysis and Rasch model fit analyses equivocally supported the unidimensionality of the item pool. DIF analyses between participants with right versus left hemisphere stroke suggested multidimensionality. Scaling cognition and communication items separately resulted in different person scores for a significant number of patients and greater responsiveness to group differences.

Conclusions: Patient-reported scales assessing communication along with more general cognitive activities may possess an internal structure that is inconsistent with a unidimensional measurement model with potential negative consequences for measurement.

Key Words: Communication disorders; Patient outcomes assessment; Rehabilitation; Stroke.

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THE PAST DECADE HAS SEEN significant advances in the measurement of patient-reported functioning and well-being.[1-6] In particular, the literature has reflected an increasing awareness of the need to measure rehabilitation outcomes related not only to physical functioning and basic activities of daily living but also cognitive functions such as problem solving, memory, and communication. The past 10 years have also seen the increasing application of IRT models to the development and validation of outcome measurement tools.[7-10] These models specify the relationship between observed responses to assessment items and the underlying variable of interest and in so doing emphasize the importance of defining the construct(s) to be measured. With respect to cognitive functioning, some have treated communication and other aspects of cognition as undifferentiated parts of the same construct,[5,6,11,12] whereas others have conceptualized them as distinct.[1,3,13]

Doyle et al[14] investigated the dimensionality of items from the communication scales of the BOSS,[3,4] the Stroke Impact Scale,[1] and the World Health Organization Disability Assessment Schedule-II.[15] They jointly calibrated these items by using the Rasch Partial Credit Model and used both item mean square fit statistics and principal components analysis of the model residuals to examine dimensionality. These analyses suggested that self-reported auditory-verbal communication may constitute a construct that is distinct from written communication and more general aspects of cognition. This investigation, however, had significant limitations. First, no a priori item-level factor analyses were conducted to evaluate the dimensionality of the item pool constructed by combining these 3 scales. Second, the utility of mean square fit statistics for testing construct dimensionality is limited.[16-19] Third, no analyses were conducted to evaluate the practical consequences of the multidimensionality that was found.

A recently developed general patient-reported outcome measure is the AM-PAC.[5] In contrast to the developers of stroke-specific scales, the authors of the AM-PAC have conceptualized patient-reported cognitive functioning as a single unitary domain and have included a range of item content related to communication, memory, problem solving, and time management in their applied cognition scale. This is an important point because the IRT and Rasch models that underlie most current patient-reported outcome scales make strong assumptions about dimensionality. The most easily applied and interpreted models require that the items respond to a single underlying construct.

List of Abbreviations

AM-PAC	Activity Measure for Post-Acute Care
BOSS	Burden of Stroke Scale
CFI	comparative fit index
CI	confidence interval
DIF	differential item functioning
IRT	item response theory
RMSEA	root mean square error of approximation

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In the initial development of the AM-PAC, a set of 58 core items covering content related to movement, mobility, self-care, learning and applying knowledge, communication, and interpersonal interaction was evaluated.[5] Factor analyses suggested the presence of three factors, labeled Physical Functioning and Movement, Personal and Instrumental Activities of Daily Living, and Applied Cognition. Item exclusions based on factor analysis results, item-scale correlations, and Rasch infit mean-square statistics resulted in a 15-item applied cognition scale consisting almost entirely of auditory-verbal communication activities.

In subsequent articles[6,11] reporting on further development of the AM-PAC applied cognition scale, additional items from other instruments were included in the item pool. In neither report were item-level factor analyses used to evaluate dimensionality before the application of a Rasch model, and in both cases the application of standard item-fit criteria resulted in scales with heterogeneous item content including communication, memory, and problem solving.

Although the results of the factor and Rasch analyses conducted on the AM-PAC have thus far been interpreted to support the unidimensionality of the applied cognition scale, there are several issues that suggest the need for further research. One issue concerns the use of item-fit statistics as indicators of dimensionality given the limitations of these statistics referenced previously.

A second issue concerns patient sampling. The sample for the AM-PAC studies included patients drawn from 3 broad groups: patients with neurologic, musculoskeletal, and medically complex diagnoses. Haley et al[5,11] reported inclusion/exclusion criteria that may have eliminated many respondents who had cognitive or communication impairment.[11] It is possible that the structure of a latent dimension such as applied cognition may differ in a population composed of patients with frank cognitive and communication impairments as opposed to a general medical population.[20] For example, one would expect communication and other aspects of cognition to be clearly dissociated in patients with motor speech impairment caused by brainstem stroke or amyotrophic lateral sclerosis.

The composition of the patient sample is also relevant to the issue of DIF. DIF analysis asks whether 2 subgroups perform differently on particular items after accounting for differences in ability on the dimension in question. The presence of DIF can be an indicator of multidimensionality if the 2 comparison groups differ systematically on some attribute indexed by a secondary dimension present in the item pool.[21,22] DIF analyses based on the severity of physical symptoms, age, sex, education, race, and diagnostic group were reported for the AM-PAC applied cognition scale. Although these analyses were informative, the lack of DIF between these groups cannot necessarily be taken as evidence for the unidimensionality of the construct. What is necessary are tests of DIF between patient subgroups hypothesized to differ systematically on potential subdomains to which specified subsets of items might respond.

The purpose of this study was to evaluate whether a set of patient-reported items measuring cognitive and communicative function in a group of right hemisphere and left hemisphere stroke survivors could be appropriately fit to a unidimensional Rasch model. The item pool was drawn from the BOSS[3,4] and was similar in size and content to the AM-PAC applied cognition short form for outpatients.[11] Conducting the analyses on a sample of right and left hemisphere stroke survivors permitted testing of specific hypotheses about the dimensionality of cognitive and communicative functioning relative to the side of the lesion. We predicted that left hemisphere stroke survivors would report more difficulty with communication activities and right hemisphere stroke survivors would report more difficulty on general cognition items. We also predicted that scaling the cognition and communication domains separately would result in more valid and responsive measurement of groups and individual participants.

METHODS

Sample

The current study used data collected from a subsample of stroke survivors who participated in the initial BOSS field trial[3] (n=281) or a subsequent longitudinal field trial[4] (n=178). Participants were recruited from rehabilitation units, outpatient clinics, and community centers across 5 US cities. The longitudinal sample met the following criteria: medical record documentation of stroke 3 months after onset (±2wk) at the time of study entry; auditory comprehension 5th percentile or greater for left hemisphere brain-injured adults on the 55-item Revised Token Test[23]; negative history of psychopathology, substance/alcohol abuse, and progressive neurologic disease; native English speaker; and visual and auditory acuity sufficient to perform protocol requirements. The initial BOSS field trial sample met the same criteria with the following additions/exceptions: 3 months or more after onset; community dwelling; negative history of pulmonary disease, cancer, and human immunodeficiency virus/acquired immunodeficiency syndrome; and performance 5th percentile or greater on subtest VIII of the Revised Token Test[24] (instead of the 55-item Revised Token Test).

Participants with bilateral, posterior fossa, or undetermined sites of lesion (n=143) were excluded from the present analyses, leaving 176 participants with unilateral left hemisphere stroke and 140 with unilateral right hemisphere stroke. Of these participants, 137 (43%) were female, and 74 (23%) were nonwhite. The mean ± SD age of the sample was 62.6±13.8 years, and the mean ± SD years of education were 13.5±2.9. The type of stroke was thromboembolic in 208 (66%) cases, hemorrhagic in 54 (17%), and undetermined in 54 (17%). All participants were community dwelling and 3 months or more after the onset of stroke. Table 1 displays the distributions of Modified Rankin[25] and Boston Diagnostic Aphasia Exam Severity Rating[26] Scale ratings in the present sample.

Assessment Instruments and Data-Collection Procedures

The data-collection procedures of both prior studies from which the data were drawn included interviewer-assisted administration of the BOSS by a licensed speech-language pathologist. The Shortened Porch Index of Communicative Ability,[27] the 55-item Revised Token Test,[28] and the National Institutes of Health Stroke Scale[29] were also administered to the longitudinal sample. The BOSS cognition and communication domain scales have good internal consistency reliability (Cronbach α, .87–.91)[3,4] and good test-retest reliability (.86 and .88, respectively).[4] The item content and response scale are displayed in table 2.

Data Analysis

Initially, we conducted a series of item-level confirmatory factor analyses with Mplus version 5.02[30,b] by using the weighted least squares mean and variance-adjusted estimator. We estimated 1-factor models for the full 11-item set and for the cognition and communication domains separately. Also, consistent with current practice for evaluating dimensionality in the context of IRT modeling,[12,31-33] we conducted a bifactor